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The Naval Postgraduate School (NPS) has graduated its first cohort of students through the Master of Cyber Systems and Operations (CSO) degree program, and student-driven research is already showing promise, and producing results.

CSO student, Navy Lt. Billy Brinkmeyer's paper on Internet mapping won first runner-up honors before an international body of experts at the Active and Passive Measurement Conference, where leading Internet measurement researchers and top universities present the results of their research.

"The work that I focused on in my paper is primarily involved with Internet Protocol Version 6 (IPv6) router alias discovery. Essentially, I was trying to develop an accurate map of the IPv6 Internet," said Brinkmeyer.

To accomplish Brinkmeyer's task, he developed what he calls the "Too Big Trick" program – an application designed to illuminate the various hubs, routers and pathways that collectively make up the IPv6 Internet.

"When you send an e-mail or visit a web page your data travels across the Internet through routers, it's like a freeway and the routers are the overpasses. We are trying to identify the freeways and determine how they connect to one another," said Brinkmeyer.

"We do not know how people are connected to each other and we want to be able to see them across the entirety of the Internet … If these are freeways, we need to be able to see them so that when an accident occurs, we can find it and deal with it," said NPS Department of Computer Science Assistant Professor Rob Beverly, who served as Brinkmeyer's thesis advisor.

Naval Postgraduate School (NPS) cyber graduate, Navy Lt. Billy Brinkmeyer, left, and NPS Department of Computer Science Assistant Professor Rob Beverly, right, are pictured inside NPS' Hamming High Performance Computing Center. Brinkmeyer is one of several students from the university's first cohort of graduates from the Master of Cyber Systems and Operations program.

Brinkmeyer's work stems from a recent government mandated network upgrade that requires networks to upgrade from IPv4 to IPv6, a mandate that changed the way network managers see the network.

"We are trying to get a picture of the IPv6 network … A lot of people have done a lot of work mapping the IPv4 network, but when it comes to IPv6, nobody has been able to see it correctly. It's a whole new network that the government has mandated providers to adopt," said Beverly.

"The 'Too Big Trick' tricks routers on the network so that we can identify them and develop a map of the IPv6 network … We want to be able to know where every connection that links into your network exists so that you can determine what your vulnerabilities are," Brinkmeyer continued. "Certain routers make up critical infrastructure, and you need to know where those critical infrastructures are located so you can prevent vulnerabilities."

Brinkmeyer and his associates were able to test their program on a "ground truth system," a known network containing over 50,000 unique interfaces. During their tests, 70 percent of the routers on the network responded to a ping, and of those that responded to the technique, Brinkmeyer was able to identify 100 percent of the responders.

Fellow CSO student, Navy Lt. Samuel Trassare's work is also showing promise. He submitted a paper, still under review, exploring a technique that obscures friendly networks thereby impeding adversarial network attackers.

"When an adversary comes probing for the topology of your network, he uses a program called Traceroute that reports every hop along the path to a destination of the adversary's choosing. I came up with a program that intercepts that probe and instead of returning a truthful route, the program sends back a false route of my own choosing in order to deceive the adversary," said Trassare.

"Sam Trassare's thesis is useful because it allows us to hide our network in such a way that the enemy is not able to identify weaknesses or single points of failure within our network," said NPS Cyber Academic Group Chair, Dr. Cynthia Irvine.

Trassare has gone on to work at the U.S. Cyber Command, commanded by another NPS alumnus, Army Gen. Keith B. Alexander.

"The CSO program is just what the Navy needs if the next big battle is going to take place in the cyber domain," said Trassare. "I am coming to Cyber Command to stand watch for them in their intelligence cell. I have a very strong technical background, but what I got out of the CSO program is insight into how to apply strategy and policy to the cyber domain – how we go about identifying and defending against attacks on friendly networks."

Irvine stresses that projects like Brinkmeyer's and Trassare's are relevant to ongoing operations, and that they offer immediate value to Navy cyber operations.

"Their theses are applicable right now, their techniques and strategies can be put to use rather quickly," said Irvine. "The two theses complement each other, one illuminates the network and the other obscures it from the adversary."

Irvine is visibly proud of her fist batch of cyber systems graduates, and is hopeful the Navy can take full advantage of their unique education.

"We are hoping that the Navy will place our students in areas where they can use their skills," said Irvine. "The Navy has a great need for people with cyber skills, talents and expertise – cyber operations are different from kinetic operations. A new way of thinking is required to operate within the cyber domain and these students have been exposed to that thinking. They can plan and execute cyber missions," said Irvine.

As chair of the Cyber Academic Group, which manages the CSO degree program, Irvine has voiced a commitment to adapt their program as new developments in the dynamic cyber area of operations are realized.

"Cyber is an area that is constantly evolving … The landscape is evolving, techniques are changing and policies are being formulated. The curriculum must stay abreast of all these changes," said Irvine.

"This first cohort of students were our pioneers, and as a result of their feedback, we have made adjustments to our program that future students will benefit from," continued Irvine. "The curriculum gives us the opportunity to do very substantive work that is of direct benefit to the Navy and the Department of Defense."

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